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(54) **NETWORK ACCESS CONTROL FOR CLOUD SERVICES**

(75) Inventors: **Robert Koeten**, Menlo Park, CA (US);
Nicolas Popp, Menlo Park, CA (US)

(73) Assignee: **Symantec Corporation**, Mountain View, CA (US)

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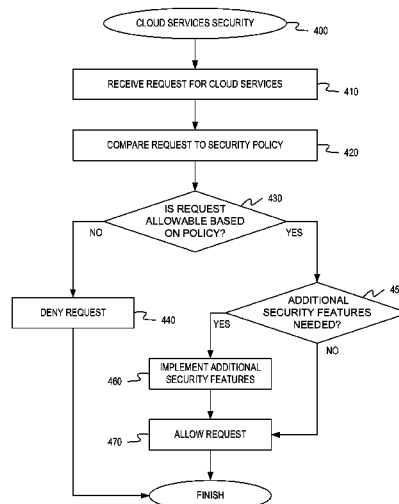
Primary Examiner — Kambiz Zand
Assistant Examiner — Noura Zoubair

(74) *Attorney, Agent, or Firm* — Lowenstein Sandler LLP

(57) **ABSTRACT**

A cloud service access and information gateway receives, from a user device, a request to access a cloud service. The cloud service access and information gateway compares a security status of the user device to a network access control policy for the cloud service. If the security status satisfies a condition of the network access control policy, the cloud service access and information gateway grants the user device access to the cloud service. If the security status does not satisfy the condition of the network access control policy, the cloud service access and information gateway requests an update to the security status of the user device to satisfy the condition.

20 Claims, 7 Drawing Sheets



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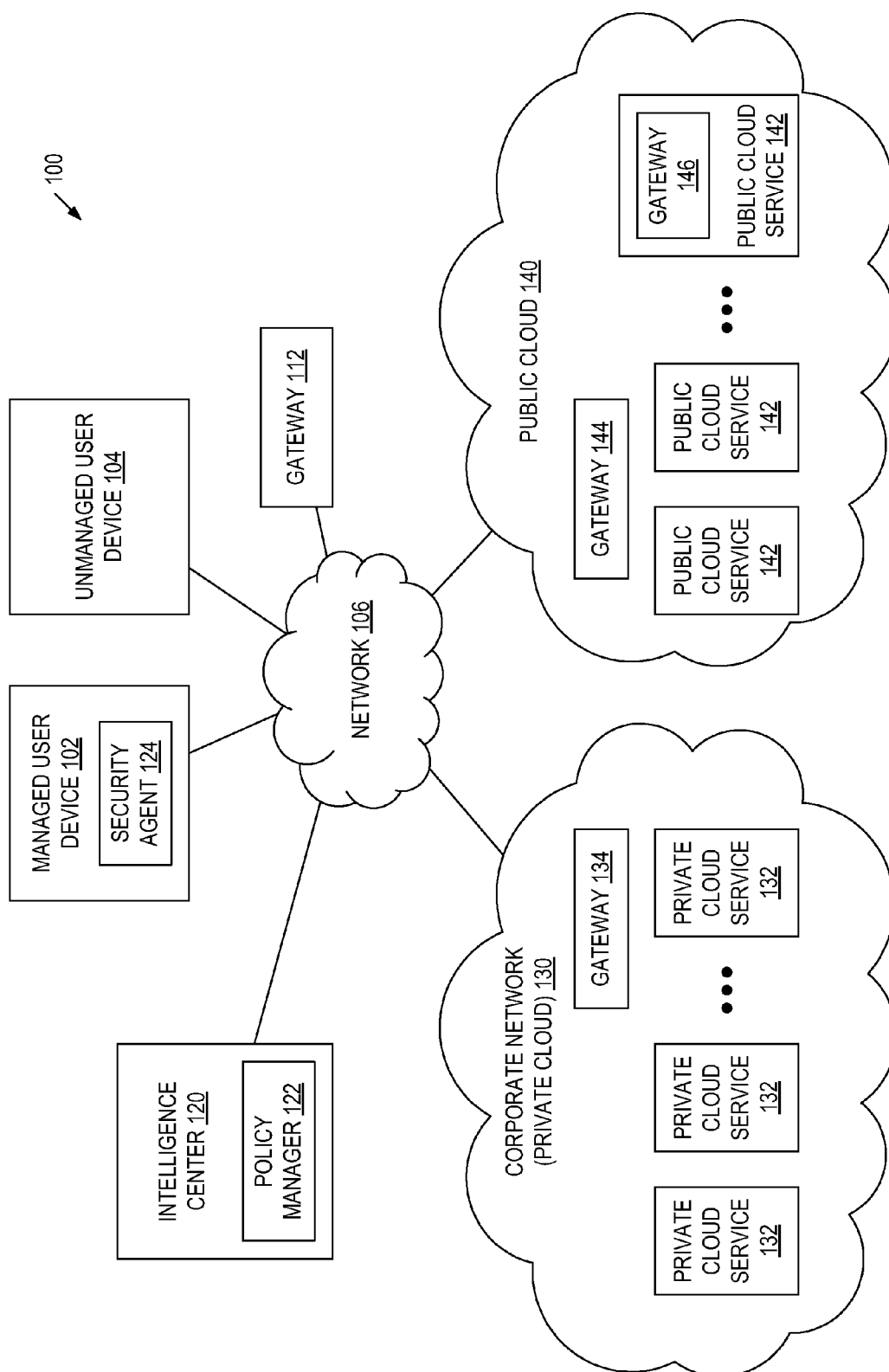


FIG. 1

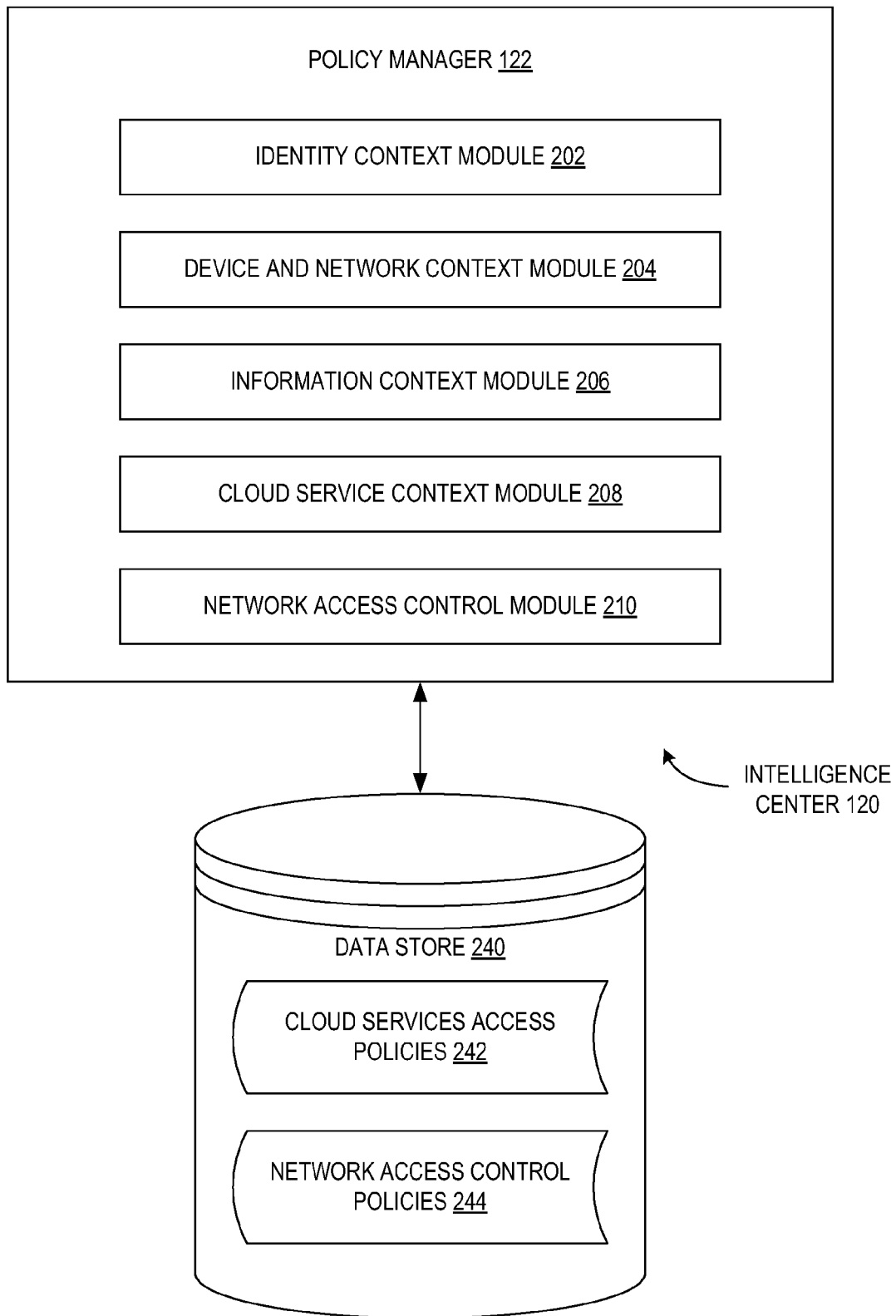


FIG. 2

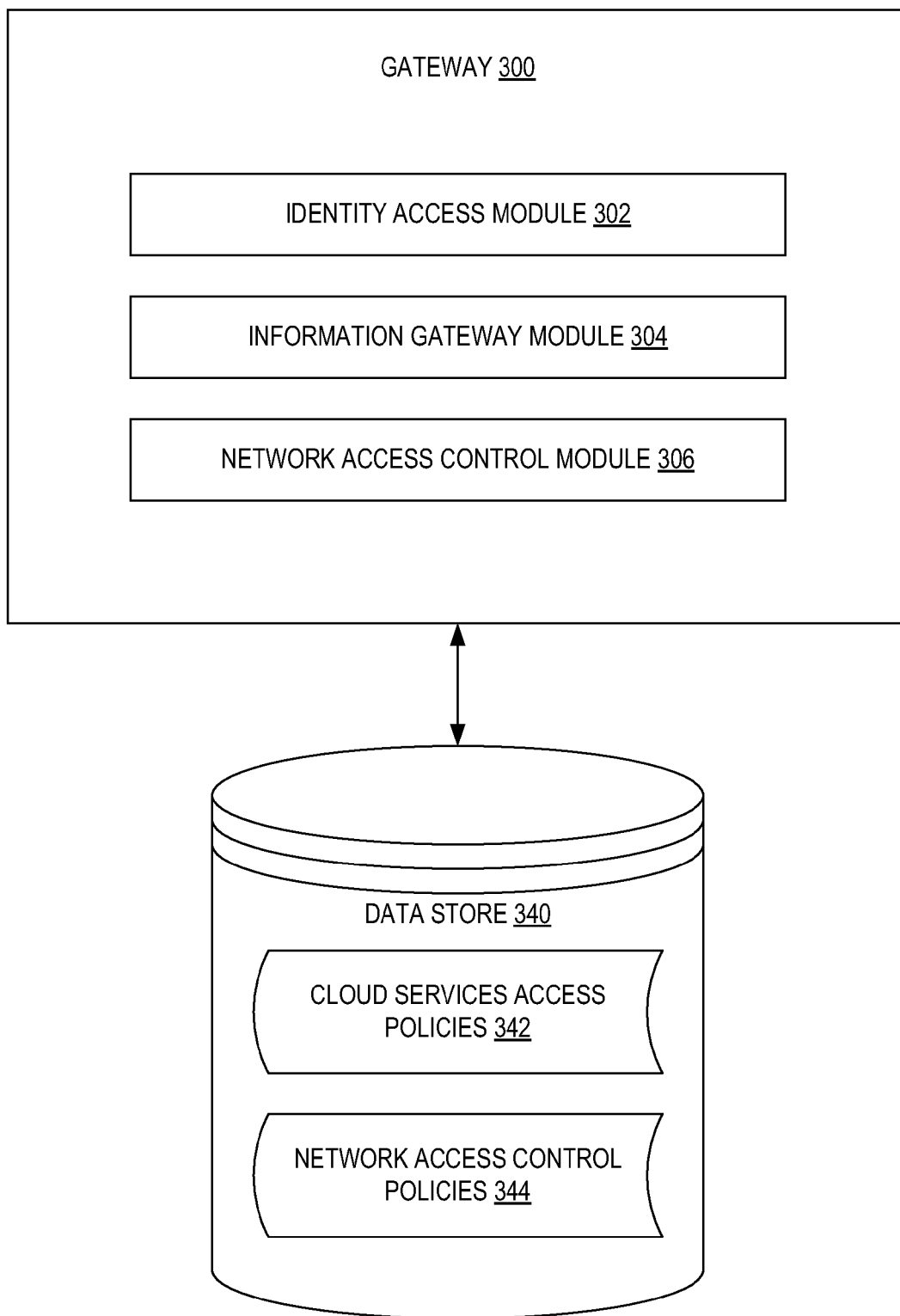


FIG. 3

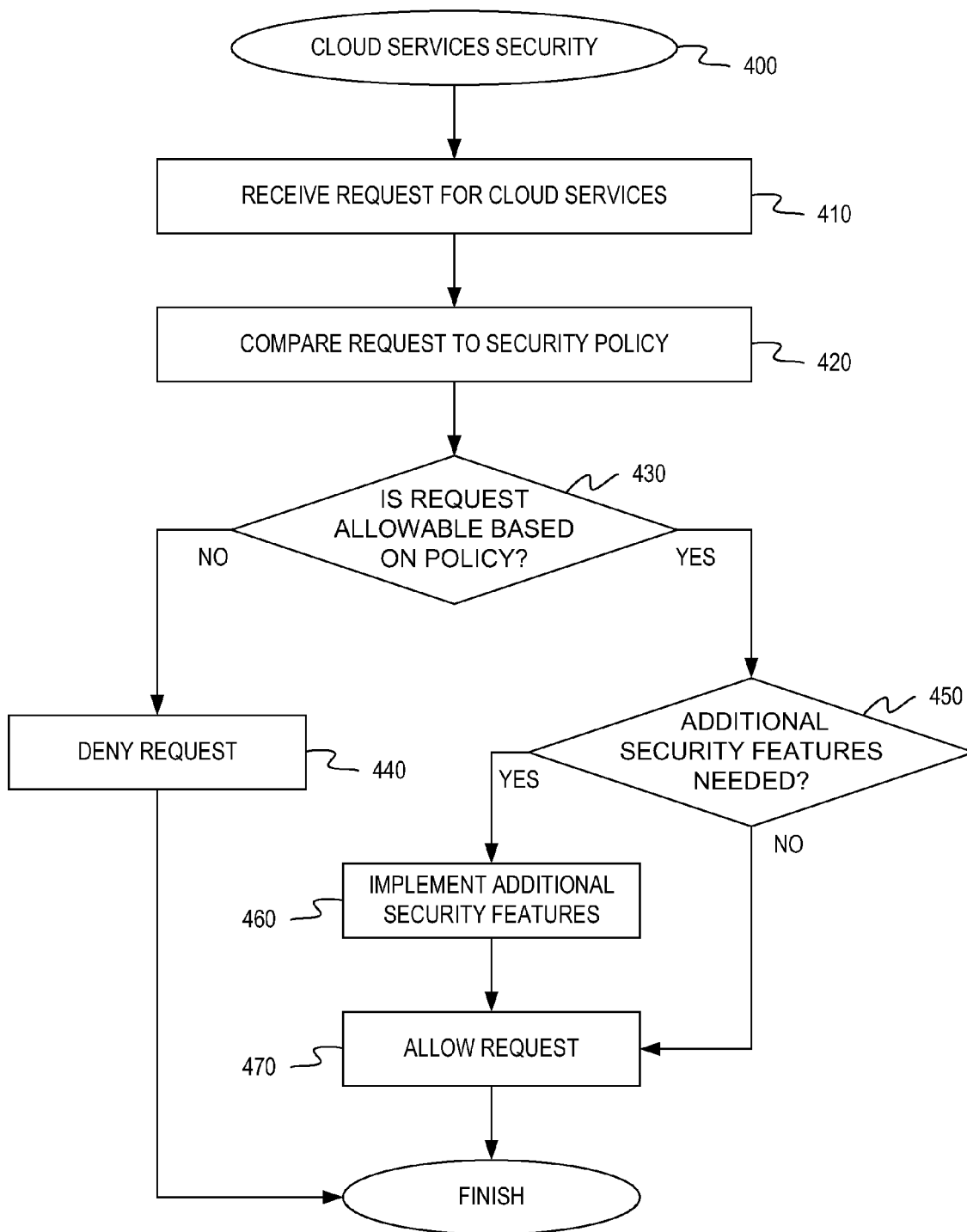


FIG. 4

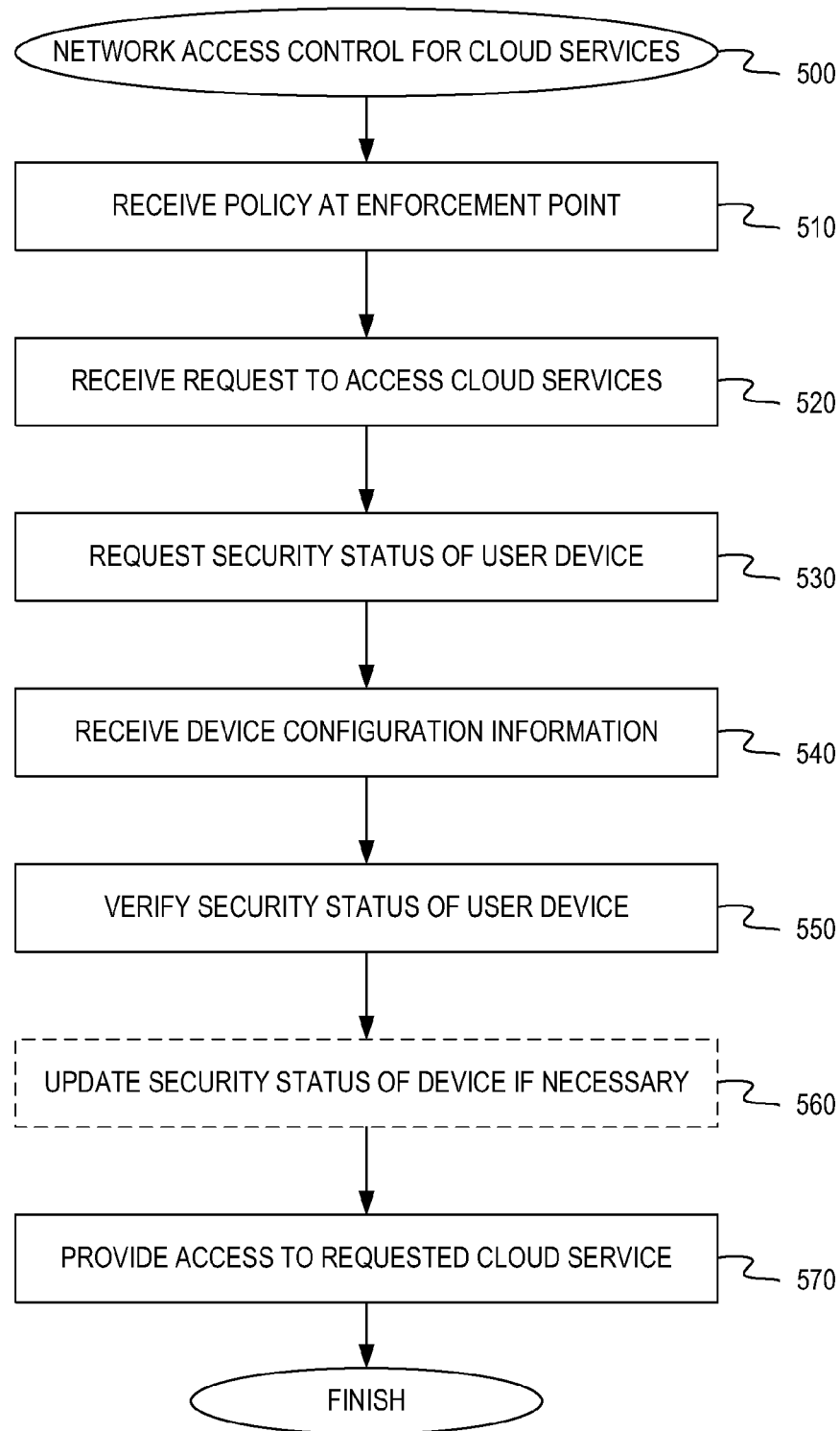


FIG. 5

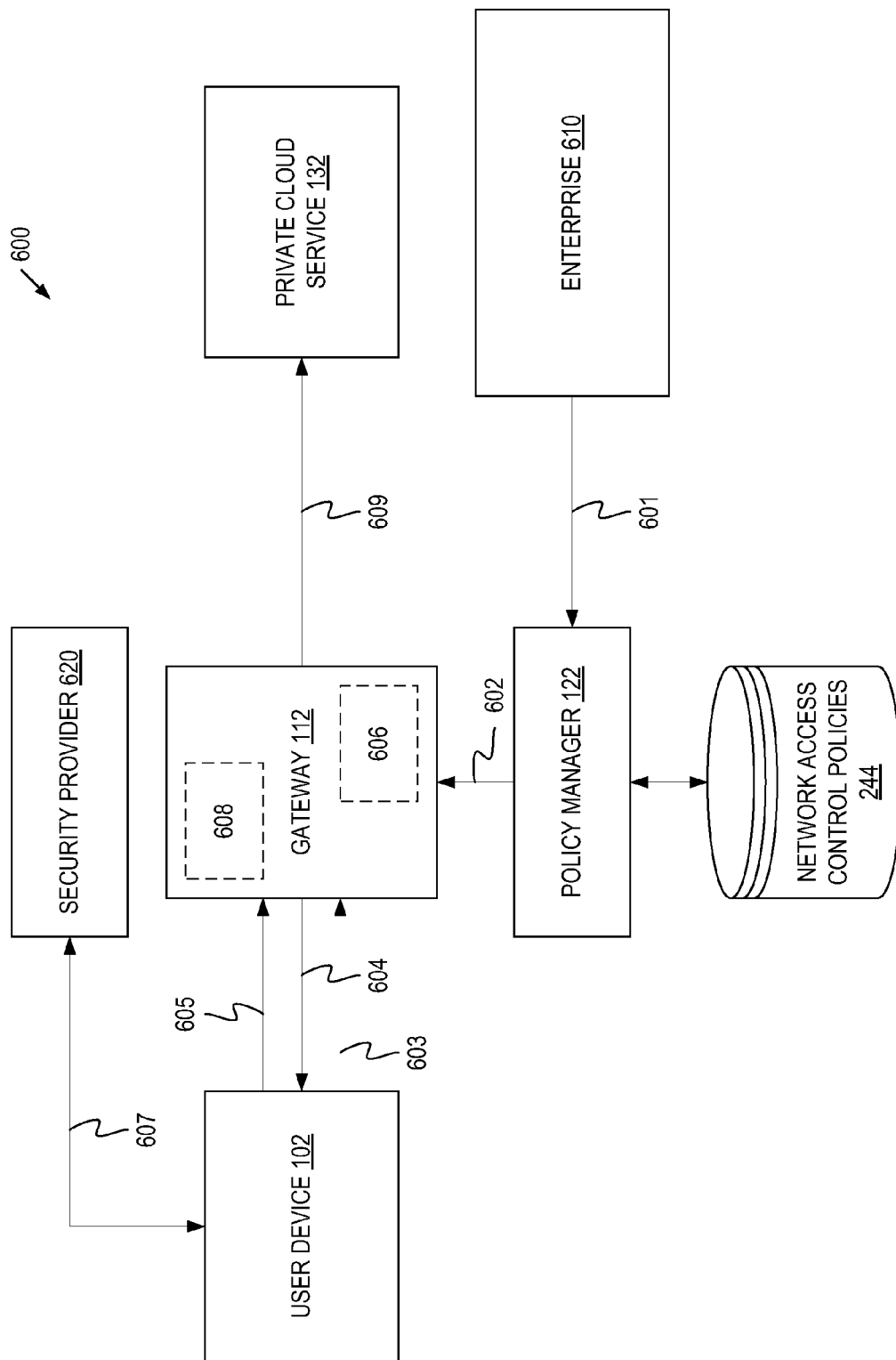


FIG. 6

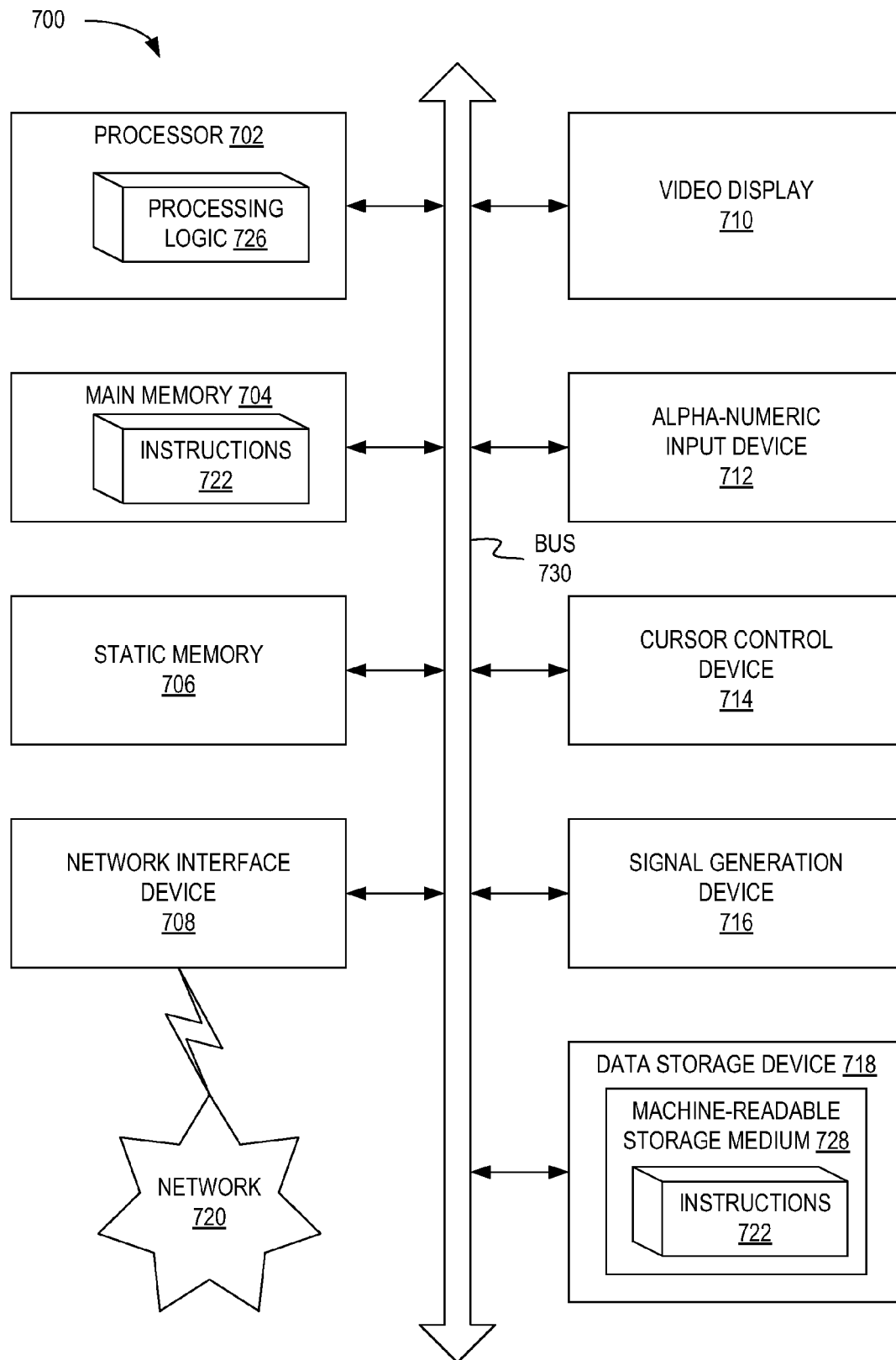


FIG. 7

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NETWORK ACCESS CONTROL FOR CLOUD SERVICES**RELATED APPLICATIONS**

This application is related to and claims the benefit of U.S. Provisional Patent Application No. 61/482,192, filed May 3, 2011, which is hereby incorporated by reference herein.

FIELD

Embodiments of the invention relate to network access control, and in particular to network access control for cloud services.

BACKGROUND

Network Access Control (NAC) is a computer networking solution that uses a set of protocols to define and implement a policy that describes how to secure access to network nodes by devices when they initially attempt to access the network. NAC might integrate the automatic remediation process (fixing non-compliant nodes before allowing access) into the network systems, allowing the network infrastructure such as routers, switches and firewalls to work together with back office servers and end user computing equipment to ensure the information system is operating securely before interoperability is allowed. Network Access Control aims to control access to a network with policies, including pre-admission endpoint security policy checks and post-admission controls over where users and devices can go on a network and what they can do.

When a computer connects to a computer network, it is not permitted to access anything unless it complies with a business defined policy. Once the policy is met, the computer is able to access network resources and the Internet, within the policies defined within the NAC system. Access to the network will be given according to profile of the person. For example, in an enterprise, a member of the human resources department may access only human resources department files.

Organizations may offer one or more cloud services to users over a network (e.g., the Internet). The cloud services may include computation, software, data access, storage services, etc. that physically reside elsewhere (e.g., another computer or the organizations data center) which users can access from their own computer or device over the network. Since sensitive information may be sent to or received from these cloud services, corporate policy may dictate that a user have a certain level of security or protection on the device being used to access the cloud services. If the user device is not connected to the corporate network, it may not be possible to check and receive the latest updates for the device's security.

SUMMARY

A method and apparatus for network access control for cloud services is described. In one embodiment, a cloud service access and information gateway receives, from a user device, a request to access a cloud service and/or specific information contained therein. The information gateway compares a security status of the user device to a network access control policy for the cloud service. If the security status satisfies a condition of the network access control policy, the information gateway grants the user device access

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to the cloud service or information. The cloud service may include one of a public cloud service and a private cloud service.

In one embodiment, the network access control policy specifies that the request should be granted if the condition is satisfied. The condition may include one of a presence of security software, a presence of a security agent, a security signature and an encryption capability. In one embodiment, the information gateway is independent of the user device and the cloud service. If the security status does not satisfy the condition of the network access control policy, the information gateway requests an update to the security status of the user device so that the condition is satisfied.

In addition, a system for network access control of cloud services is described. An exemplary system may include a memory and a processor coupled with the memory. In one embodiment, the processor is to receive a request to access a cloud service from a user device. The processor may compare a security status of the user device to a network access control policy for the cloud service. If the security status satisfies a condition of the network access control policy, the processor grants the user device access to the cloud service.

Further, a computer-readable storage medium network access control of cloud services is described. An exemplary computer readable storage medium provides instructions, which when executed by a processor causes the processor to perform a method such as the exemplary methods discussed above.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the present invention, which, however, should not be taken to limit the present invention to the specific embodiments, but are for explanation and understanding only.

FIG. 1 is a block diagram of an exemplary network architecture, in which embodiments of the present invention may operate.

FIG. 2 is a block diagram illustrating a network access control policy manager, according to an embodiment.

FIG. 3 is a block diagram illustrating a cloud service access and information gateway, according to an embodiment.

FIG. 4 is a flow diagram illustrating a cloud services security method, according to an embodiment.

FIG. 5 is a diagram illustrating a network access control method for cloud services, according to an embodiment.

FIG. 6 is a diagram illustrating a workflow for network access control for cloud services, according to an embodiment.

FIG. 7 is a block diagram illustrating one embodiment of a computer system, according to an embodiment.

DETAILED DESCRIPTION

The following description sets forth numerous specific details such as examples of specific systems, components, methods, and so forth, in order to provide a good understanding of several embodiments of the present invention. It will be apparent to one skilled in the art, however, that at least some embodiments of the present invention may be practiced without these specific details. In other instances, well-known components or methods are not described in detail or are presented in simple block diagram format in order to avoid unnecessarily obscuring the present invention. Thus, the specific details set forth are merely exemplary. Particular imple-

mentations may vary from these exemplary details and still be contemplated to be within the scope of the present invention.

Embodiments of a method and apparatus are described for network access control for cloud services. In one embodiment a cloud services access and information gateway may be located, for example, somewhere in a network, in a private or public cloud, or in a cloud service. The cloud service access and information gateway receives, from a user device, a request to access a cloud service. The cloud service access and information gateway may determine and compare a security status of the user device to a network access control policy for the cloud service. If the security status satisfies a condition of the network access control policy, the cloud service access and information gateway grants the user device access to the cloud service. If the security status does not satisfy the condition of the network access control policy, the cloud service access and information gateway may request an update to the security status of the user device so that the condition is satisfied.

The cloud service access and information gateway may provide network access control in a way that is independent of either the type of user device sending the request or the cloud service that is requested. Since the cloud service access and information gateway may be located somewhere in the network between the user device and the cloud service, the network access control techniques described herein may work with any number of different device and/or services. This allows for network access control, and the verification of a device's security status without the need for the user device to connect to a corporate network (e.g. through a virtual private network (VPN)). An update to the security configuration and status may be performed dynamically and in real time in response to the request. If an access request is received from a device without the security features defined in the policy, before responding to the request, a network access control module may update the security features on the device to conform to the policy. Once the policy is satisfied, access to the requested cloud service may be granted. This may prevent a user from being denied access to a cloud service that he would otherwise be allowed to access, merely because he has not been able to previously update the security features of his user device.

FIG. 1 is a block diagram of an exemplary network architecture 100, in which embodiments of the present invention described herein may operate. The network architecture 100 may include corporate network (i.e., private cloud) 130, public cloud 140 (including services not managed by the corporation and included in private cloud 130) and one or more user devices 102, 104 capable of communicating with the corporate network 130 and public cloud 140 via a network 106. Network 106 may include, for example, a private network such as a local area network (LAN), a wide area network (WAN), a global area network (GAN) such as the Internet, or a combination of such networks, and may include a wired or wireless network.

The user devices 102, 104 may be portable computing devices such as laptop or tablet computers. Other examples of portable computing devices include cellular telephones (e.g., smartphones), personal digital assistants (PDAs), portable media players, netbooks, and the like. The user devices 102, 104 may also be non-portable computing devices such as desktop computers, set-top boxes associated with a television, gaming consoles, and so on. The user devices 102, 104 may be variously configured with different features to enable access to the various cloud services 132, 142 made available by corporate network 130 and public cloud 140.

In one embodiment, the user devices are categorized as managed user devices 102 and unmanaged user devices 104. Managed user devices 102 may include devices provided by the organization or corporation that manages corporate network 130. For example, if a user is an employee of a corporation, the corporation may issue the employee a laptop computer and a smartphone. These devices may or may not be owned by the corporation, but as long as the corporation maintains an element of control over the devices, they may qualify as managed user devices 102. In some embodiments, the corporation may have control over what applications or programs are installed and run on managed user devices 102. For example, managed user devices 102 may have a security agent 124 installed thereon to monitor data sent to and from the managed user device 102, to encrypt or decrypt data transmissions, identify threats or suspicious behavior, etc. In other embodiments, the corporation may exert other forms of control over managed user devices 102.

Unmanaged user devices 104 include all other user devices that do not qualify as managed user devices 102. Unmanaged user devices 104 may include personal devices owned by the user or employee. For example, unmanaged user devices 104 may include a user's home computer or personal cell phone. Generally, the corporation has no control over what applications and programs are installed and run on unmanaged user devices 104, and unmanaged user devices 104 would not typically include security or data loss prevention software, such as security agent 124. In some embodiments, both managed user devices 102 and unmanaged user devices 104 may be used to access various available cloud services.

Cloud computing may refer to the access of computing resources over a computer network. A common shorthand for a cloud computing service (or an aggregation of all existing cloud services) is "the cloud." Cloud computing allows for a functional separation between the computing resources used and the physical machine where the user is working. The computing resources may reside in a local network or outside the local network, for example, in an internet connected data-center. A user may access the resources in the cloud (e.g., corporate network 130 or public cloud 140) using a personal computer (PC), workstation, laptop computer, mobile phone, personal digital assistant (PDA), tablet computer or the like, including managed user device 102 and unmanaged user device 104. The principle behind the cloud is that any computer connected to the Internet, or other network, is connected to the same pool of computing power, applications, and files. For example, users can store and access personal files, such as music, pictures, videos, and bookmarks, play games, or use productivity applications and cloud services on a remote server rather than physically carrying around a storage medium such as a DVD or hard drive.

Since the cloud is the underlying delivery mechanism, cloud based applications and services may support any type of software application or service in use today. All of the development and maintenance tasks involved in provisioning the applications are performed by a service provider (e.g., the corporation). The user's computer may contain very little software or data (perhaps a minimal operating system and web browser only), serving as little more than a display terminal for processes occurring on a network of computers, potentially located far away. Cloud computing frees users from certain hardware and software installation and maintenance tasks through the use of simpler hardware that accesses a vast network of computing resources (processors, servers, data storage devices, etc.). The sharing of resources reduces the cost to individuals and users may routinely use data inten-

sive applications and services driven by cloud technology which were previously unavailable due to cost and deployment complexity.

Corporate network **130** and public cloud **140** may each include a group of networked computing resources accessible to the user devices **102**, **104** over network **106**. The resources available in corporate network **130** and public cloud **140** may include, for example, processing devices, storage devices, applications, or other resources. In one embodiment corporate network **130** may be a private cloud that is operated solely for a single organization, such as a corporation. Corporate network **130** may be managed internally by the corporation or by a third-party, and may be hosted internally or externally. Public cloud **140** may represent cloud computing in the more traditional sense, where resources are dynamically provisioned to the general public on a fine-grained, self service basis. Public cloud **140** may provide services and resources from a variety of service providers and may be jointly managed by the providers or managed by a third-party.

In one embodiment, corporate network **130** may include one or more private cloud services **132**. Private cloud services **132** may include applications or programs made available to users of user devices **102**, **104**. Private cloud services **132** may include services created by the organization that manages corporate network **130** (e.g., the corporation) and/or services created by a third party, but provided and managed by the corporation for its users (e.g., employees). Private cloud services **132** may include, for example, an email service, a document management service, a customer relationship management (CRM) service, a video communication service, or some other cloud service. Select users may be afforded access to private cloud services **132** in corporate network **130** using managed user devices **102** or unmanaged user devices **104** over network **106**.

In one embodiment, public cloud **140** may include one or more public cloud services **142**. Public cloud services **142** may include applications or programs made available to users of user devices **102**, **104**. Public cloud services **142** may include services created, provided and managed by a variety of different organizations or service providers. Each public cloud service **142** may be used by a user for either personal or business purposes, and some public cloud services **142** may be used for both purposes. Public cloud services **142** may include similar and/or different services as private cloud services **132**, such as for example, an email service, a document management service, a social networking service, a customer relationship management (CRM) service, or some other cloud service. When compared to corporate network **130**, a larger portion of users (or in one embodiment, all users of the Internet) may be afforded access to public cloud services **142** in public cloud **140** using managed user devices **102** or unmanaged user devices **104**.

Network architecture **100** may also be designed with data loss prevention (DLP) features to protect access to private services and confidential information maintained by an organization. Confidential information may be stored in a structured form such as a database, a spreadsheet, etc., and may include, for example, customer, employee, patient or pricing data. In addition, confidential information may include unstructured data such as design plans, source code, financial reports, human resources reports, customer or patient reports, pricing documentation, corporate mergers and acquisitions documentation, government (e.g. Securities and Exchange Commission) filings, and any other confidential information that requires restricted user access. In one embodiment, the

data loss prevention may be implemented by intelligence center **120**, and a series of one or more security gateways **112**, **134**, **144**, **146**.

The data loss prevention features may protect confidential information using policies, which may be controlled by policy manager **122** in intelligence center **120**. In one embodiment, intelligence center **120** may be a computing system or a series of computing systems managed, for example, by the organization which manages corporate network **130**. In one embodiment, intelligence center **120** may be separate from corporate network **130** as shown, however, in other embodiments, intelligence center **120** may be implemented using computing resources inside corporate network **130**. Additional details of policy manager **122** are provided below with respect to FIG. 2.

The design of the data loss prevention features may allow a user or system administrator to define, aggregate and enforce identity, device, information and service centric policies in a uniform, consistent fashion irrespective of whether a user accesses a cloud service with their personal or corporate credentials, from a managed or unmanaged device, from a known or unknown network, or for personal or corporate related purposes. The system combines a cloud federated single sign-on (SSO) solution with the cloud service access and information gateways **112**, **134**, **144**, **146** and the capability to grant or decline cloud service access and/or information access/transfer/transformation based on an individual's validated identity, device and network context (e.g. managed device through an unknown network), information classification policy context and the cloud service context (e.g. web portal vs. financial management application).

The cloud service access and information gateways **112**, **134**, **144**, **146** may serve as policy enforcement points to enforce the policies set by policy manager **122**. For example, a request to access a cloud service, such as private cloud service **132** or public cloud service **142**, may be passed through one of the cloud service access and information gateways. The cloud service access and information gateway may compare the request to the conditions of the applicable policy, and enforce an action based on the result of the comparison. The action may include, for example, allowing the request, denying the request, modifying the request, or some other action. In one embodiment, network architecture **100** may include one or more cloud service access and information gateways located at various different locations. For example, cloud service access and information gateway **112** may be connected to or be a part of network **106**. Communication between the user devices **102**, **104** and corporate network **130** and public cloud **140** may be enabled via any communication infrastructure. One example of such an infrastructure includes a combination of a wide area network (WAN) and wireless infrastructure, which allows a user to access the cloud services. The wireless infrastructure may be provided by one or multiple wireless communications systems. In one embodiment, the wireless communication system may be a wireless fidelity (WiFi) hotspot connected with the network **106**. The wireless communication system may also be a wireless carrier system that can be implemented using various data processing equipment, communication towers, etc. Alternatively, or in addition, the wireless carrier system may rely on satellite technology to exchange information with the user devices **102**, **104**. Cloud service access and information gateway **112** may be implemented as part of this infrastructure, such that all communications are able to be intercepted by the gateway **112**.

In another embodiment, cloud service access and information gateways may be alternatively or additionally located

within corporate network **130**, such as gateway **134**, and within public cloud **140**, such as gateway **144**. Since all network traffic passes through one of the gateways, during peak times of high traffic, a bottleneck may form reducing response times. Placing the gateways **134**, **144** within corporate network **130** and public cloud **140** respectively, can alleviate this bottleneck, because the amount of traffic passing through each gateway is reduced. Gateway **134** need only handle traffic intended for private cloud services **132** and gateway **144** need only handle traffic intended for public cloud services **142**. In another embodiment, gateway **146** may be alternatively or additionally located within a cloud service, such as for example, public cloud service **142**. Additional details of cloud service access and information gateways **112**, **134**, **144**, **146** are provided below with respect to FIG. 3.

FIG. 2 is a block diagram of one embodiment of policy manager **122** that is included in intelligence center **120**. In one embodiment, policy manager **122** may include identity context module **202**, device and network context module **204**, information context module **206**, cloud service context module **208**, and network access control module **210**. In one embodiment, policy manager **122** is connected to a data store **240**, which may be a file system, database or other data management layer resident on a data storage device such as a disk drive, RAM, ROM, database, etc.

Policy manager may be responsible for defining and managing a set of policies defining access to the various cloud services in a network, such as private cloud services **132** and public cloud services **142**. The resulting policies may be stored in data store **240**, for example, as cloud services access policies **242**. The policies **242** may be specifically defined for certain access requests or indirectly defined based on a number of factors or contexts. For example, a request that has a certain combination of factors may be treated according to a certain policy. The policies **242** may be created or defined, for example, by a user, system administrator, or other person or entity.

Identity context module **202** is concerned with the identity of the user making a request to access a cloud service and/or cloud information. Regardless of the device used to make the request (e.g., managed user device **102** or unmanaged user device **104**), a user may identify himself using login credentials. The login credentials may include, for example, a user name and password. In one embodiment, the login credentials are part of a single sign-on (SSO) system. SSO is a property of access control of multiple related, but independent software systems (e.g., private cloud services **132** and public cloud services **142**). With SSO, the user logs in once and gains access to all (or a certain subset) of the services without being prompted to log in again at each of them. As different services may support different authentication mechanisms, using SSO, the gateway may internally translate and store different credentials compared to what is used for the initial SSO login.

In one embodiment, the login credentials provided by the user may vary depending on his status. For example, the user may have a certain user name or login if he is a member of a first group, such as being an employee of the corporation that manages corporate network **130**. If the user is not a member of the first group, he may have a different set of login credentials, identifying him as such. In addition, the login credentials may provide other information about the user, such as rank, title, position, or other information. Identity context module **202** may interpret different forms of login information to determine the associated identity of a user with those login credentials, and define a corresponding policy. For example, in one embodiment, only users who are employees

of the corporation may be allowed to access private cloud services **132**, while non-employees are denied access.

Device and network context module **204** is concerned with the type and status of device and network from which a request to access a cloud service is made. As discussed above, user devices are generally categorized as managed user devices **102** or unmanaged user devices **104**, including publicly shared user devices. The corporation, or other organization, may have some element of control over managed user device **102**, such as requiring that some security software be installed on the managed user device **102**, such as security agent **124**. Security agent **124** may ensure that the information transferred to and from managed user device **102** is safe and secure. Thus, in one embodiment, device and network context module **204** may define a policy that allows any communication from a managed user device **102** to private or corporate cloud services **132**. Requests to access cloud services from an unmanaged user device **104** may be denied, according to the policy. In another embodiment, the policy may dictate that such requests from unmanaged user devices **104** be additionally encrypted or otherwise secured.

The network **106** through which the request to access a cloud service is made may also be considered by device and network context module **204**. Network **106**, may be for example, a secured or unsecured LAN, a WAN, a mobile telecommunications network, or some other network. Device and network context module **204** may define certain access policies **242** based on the type of network as well. For example, only requests from secure networks may be granted access to private cloud services **132**. In another embodiment, the location of the network may also be considered when defining the policy. For example, a request made over a wireless network in the United States may be allowed access to certain cloud services, while a request made over a wireless network in Europe may only be granted for a different set of cloud services.

Information context module **206** is concerned with the type of information which is requested to or sent from a cloud service. The information may be classified in any number of different ways, such as corporate or personal, confidential or public, critical or non-critical, etc. Information context module **206** may define certain access policies **242** based on the type of information being communicated. Each of the different contexts, including the information context, may be combined with one or more other contexts when defining the policies **242**. In one embodiment, with respect to the information context, a policy may allow corporate data only to be received by a managed user device **102** or sent only to an employee of the corporation.

Cloud service context module **208** is concerned with the type of cloud service for which access is requested. As discussed above, cloud services are generally categorized as private cloud services **132** or public cloud services **142**. Private cloud services **132** may include services created by the organization that manages corporate network **130** (e.g., the corporation) and/or services created by a third party, but provided and managed by the corporation for its users (e.g., employees). Public cloud services **142** may include services created, provided and managed by a variety of different organizations or service providers. The cloud service context may also be affected by the type of service requests (e.g., read, write, delete) as well as a service subdomain (e.g., the scope of the requested information) as determined by a more granular URL or URI. The policies **242** may allow access to the different cloud services based on any combination of one or more of the other contexts. For example, a policy may only allow access to private cloud services **132** from a managed

user device **102** or over a secured network. One of skill in the art would recognize that there are many other possible combinations that could form the policies beyond those described herein.

Network access control module **210** may define policies related to network access control. These policies may be stored in data store **240** as network access control policies **244**. In one embodiment, network access control policies **244** define a certain level of security or security features required for different, users, devices, information requests, and/or cloud services. For example, network access control policies **244** may specify that a user device, such as managed user device **102** include security agent **124**. In one embodiment, the network access control policies **244** may specify that the software run by security agent **124** be of a certain version (i.e., the most recently updated version). In another embodiment, the policies **244** may require that the device have a certain security signature. In yet another embodiment, the policies **244** may require that the managed user device **102** be capable of certain types of encryption (e.g., pretty good privacy (PGP)), have a certain level of DLP features, certain types of communications protocols (e.g., secure socket layer (SSL)), or certain types of information rights management (IRM).

In one embodiment, policy manager **122** creates and manages the policies, such as cloud services access policies **242** and network access control policies **244** and distributes them to the policy enforcement points (e.g., gateways **112**, **134**, **144**, **146**). The policies may be sent to the enforcement points periodically, according to a predefined schedule, each time a change or update is made to one of the policies **242**, **244**, or in response to a request from a user or system administrator. This may ensure that the gateways **112**, **134**, **144**, **146** are able to make access decisions based on the most recent up-to-date policies.

FIG. 3 is a block diagram illustrating a cloud service access and information gateway, according to an embodiment of the present invention. In one embodiment, gateway **300** may include identity access module **302**, cloud service access and information gateway module **304**, and network access control module **306**. Cloud services access and information gateway **300** may be representative of any of cloud service access and information gateways **112**, **134**, **144**, **146**, as shown in FIG. 1, and may be located, for example, in network **106**, corporate network **130**, public cloud **140**, in a cloud service, such as public cloud service **142**, or elsewhere. In one embodiment, gateway **300** is connected to a data store **340**, which may be a file system, database or other data management layer resident on a data storage device such as a disk drive, RAM, ROM, database, etc.

In one embodiment, gateway **300** may intercept or otherwise receive an access request. The request may be sent, for example, by managed user device **102** or unmanaged user device **104** to access a cloud service, such as private cloud service **132** or public cloud service **142**. In one embodiment, the request may include information about the request, such as an identity of the user making the request, information about the device and network from which the request was made, including security information from the user device, a type of information being transmitted or requested, an indication of the cloud service to which the request is directed, and/or other information. Gateway **300** may use this information to make an access determination according to one or more access policies, such as cloud services access policies **342** and network access control policies **344**, which may be stored in data store **340**. Cloud services access policies **342** and network access control policies **344** may be generated

and distributed by a policy manager, such as policy manager **122** in intelligence center **120**.

Upon receiving the access request, identity access module **302** examines the request and makes a determination of which of cloud services access policies **342** are applicable. In one embodiment, identity access module **302** identifies an identity of the user making the request, information about the device from which the request was made, including security information from the user device and information about the network on which the request was received. In response, identity access module **302** may determine if the request should be allowed for a given cloud service according to the policies **342**. For example, identity access module **302** may determine that the request is received from an employee of the corporation, on a managed device, such as managed user device **102**, and received on a secure wireless network **106**. The policy **342** may dictate that a request with that particular combination of features should be allowed for either private cloud services **132** or public cloud services **142**. In one embodiment, the policy **342** may specify individual cloud services that may or may not be accessed, rather than just a class of services.

In one embodiment, either before or after, or in some cases at the same time that identity access module **302** verifies the identity of the request, cloud service access and information gateway module **304** may examine the request and make a determination of whether to allow the request based on policies **342**. Cloud service access and information gateway module **304** may identify a type of information that the access request is either sending to a cloud service or requesting from the cloud service. The information may be classified in any number of different ways, such as corporate or personal, confidential or public, critical or non-critical, etc. For example, cloud service access and information gateway module **304** may determine that the user is attempting to download corporate sales data from a private cloud service **132**. In one embodiment, the policy **342** may specify that such information is allowed to be downloaded by corporate employees, or by anyone using a managed user device **102**, or by some combination of these or other factors.

Upon receiving the access request, network access control module **306** examines the request and makes a determination of which of network access control policies **344** are applicable. In one embodiment network access control module **306** may be a sub-module of identity access module **302**. In one embodiment, network access control policies **344** may define a certain level of security required for different, users, devices, information requests, and/or cloud services. For example, network access control policies **344** may specify that a user device, such as managed user device **102** include security agent **124**. In one embodiment, the network access control policies **244** may specify that the software run by security agent **124** be of a certain version (i.e., the most recently updated version). In another embodiment, the policies **244** may require that the managed user device **102** be capable of certain types of encryption, have a certain level of DLP features, certain types of communications protocols, or certain types of information rights management.

In one embodiment, security information about the user device, such as managed user device **102**, may be included in the request to access one of the cloud services. In another embodiment, upon receiving the request, network access control module **306** may query the managed user device **102** to obtain the security information. Network access control module **306** may compare the determined security information from user device **102** to network access control policy **344**. Network access control policy **344** may specify that for a

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given type of information, in combination with one or more other factors, the request should be allowed, denied, or some additional action is required. For example, if network access control module 306 determines that a version of the security software on user device 102 matches a version specified by network access control policy 344, the request to access a cloud service may be allowed. As a result, gateway 300 may forward the access request to the specified cloud service. In another example, if the version of the security software on user device 102 does not match the policy 344 (e.g., it is a version prior to the one required by policy 344), network access control module 306 may require that the security software be updated to the most recent version.

If network access control module 306 determines that the security on user device 102 needs to be updated, network access control module 306 may notify a security provider (not shown). In one embodiment, the security provider may be part of intelligence center 120, corporate network 130, or some other system. The security provider may work with managed user device 102 to bring the device security into compliance with the requirements of the policy 344. For example, the security provider may upgrade the security software on user device 102, install a security agent 124 on user device 102, or otherwise upgrade or improve the device security. In one embodiment, the security provider may be a hosted security solution available over a network, such as Symantec Endpoint Protection.cloud from Symantec Corporation.

FIG. 4 is a flow diagram illustrating a cloud services security method, according to an embodiment of the present invention. The method 400 may be performed by processing logic that comprises hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software (e.g., instructions run on a processor to perform hardware simulation), or a combination thereof. The processing logic is configured to monitor requests for access to cloud services made by user devices. In one embodiment, method 400 may be performed by cloud service access and information gateway 300, as shown in FIG. 3.

Referring to FIG. 4, at block 410, method 400 receives a request to access cloud services. In one embodiment, the request may be sent by a user device, such as managed user device 102 or unmanaged user device 104. The request may be for access to a cloud service, such as private cloud services 132 or public cloud services 142. In one embodiment, cloud service access and information gateway 300, which may include for example one of gateways 112, 134, 144 or 146, may intercept or otherwise receive the access request of the user device.

At block 420, method 400 may analyze the request based on a set of one or more security policies, such as cloud services access policies 342. Cloud services access policies 342 may include policies generated and distributed by a policy manager, such as policy manager 122 in intelligence center 120. The policies 342 may be sent to gateway 300 periodically, according to a predefined schedule, each time a change or update is made to one of the policies, or in response to a request from a user or system administrator.

At block 430, method 400 determines whether the request is allowable based on the cloud services access policy 342. In one embodiment, identity access module 302 of gateway 300 identifies an identity of the user making the request, information about the device from which the request was made and information about the network on which the request was received. In response, identity access module 302 may determine if the request should be allowed for a given cloud service according to the policy 342. For example, the policy 342 may

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specify that a request with a particular combination of features should or should not be allowed for either private cloud services 132 or public cloud services 142. In addition, cloud service access and information gateway module 304 may identify a type of information that the access request is either sending to a cloud service or requesting from the cloud service. The information may be classified in any number of different ways, such as corporate or personal, confidential or public, critical or non-critical, etc. In one embodiment, the policy 342 may specify that certain types of information are allowed to be downloaded by certain users, devices, etc.

If at block 430, method 400 determines that the access should not be granted for the requested cloud service, at block 440 method 400 may deny the access request. As a result the requesting device is not allowed access to the cloud service. If at block 430, method 400 determines that the access should be granted for the requested cloud services according to policy 342, method 400 proceeds to block 450. At block 450, method 400 determines if additional security features are needed. In one embodiment, the cloud services access policy 342 or network access control policy 344 may specify that a certain level of security is required on the user device 102, 104. If the current security features of the device do not meet the requirements of the policy, at block 460, method 400 implements the additional security features dynamically and in real-time. Network access control module 306 may compare the current security of the device to the security features defined in the policy 344. In one embodiment, method 400 may upgrade the security software on user device 102, install a security agent 124 on user device 102, or otherwise upgrade or improve the device security. If at block 450, method 400 determines that additional security features are not needed, at block 470, method 400 allows the request. Gateway 300 may forward the request for access to the intended cloud service, such as private cloud service 132 or public cloud service 142.

FIG. 5 is a flow diagram illustrating a network access control method for cloud services, according to an embodiment of the present invention. The method 500 may be performed by processing logic that comprises hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software (e.g., instructions run on a processor to perform hardware simulation), or a combination thereof. The processing logic is configured to monitor and control requests for access to cloud services made by user devices. In one embodiment, method 500 may be performed by cloud service access and information gateway 300, as shown in FIG. 3.

Referring to FIG. 5, at block 510, method 500 receives a policy, such as network access control policy 344 at an enforcement point. In one embodiment, the enforcement point is an cloud service access and information gateway 300. The cloud service access and information gateway may be located in the network 106 (e.g., gateway 112), in corporate network 130 (e.g., gateway 134), in public cloud 140 (e.g., gateway 144) or within a cloud service (e.g., gateway 146). The policy 344 may be provided by policy manager 122 in intelligence center 120. In one embodiment, the policy 344 specifies a certain level of security or other security requirements required for network access.

At block 520, method 500 receives a request to access cloud services. In one embodiment, the request may be sent by a user device, such as managed user device 102 or unmanaged user device 104. The request may be for access to a cloud service, such as private cloud services 132 or public cloud services 142. In one embodiment, cloud service access and information gateway 300 may intercept or otherwise receive the access request.

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At block 530, method 500 may request a security status of the user device from which the access request was received. In one embodiment, network access control module 306 of gateway 300 may request information about the security features on user device 102, such as for example whether the user device 102 has certain security software, whether a security agent 124 is running on the user device 102, whether the device is capable of certain types of data encryption, etc. In one embodiment, network access control module 306 may also request the version of the security software or security agent or request a date at which the security was installed. At block 540, method 500 receives a response from user device 102 to the request issued at block 530. The response may include a security configuration of the user device 102.

At block 550, method 500 verifies the security status of the user device 102. In one embodiment, network access control module 306 compares the security information received at block 540 to the network access control policy 344 received at block 510. In one embodiment, network access control policies 344 may define a certain level of security or set of security features required for different, users, devices, information requests, and/or cloud services. For example, network access control policies 344 may specify that a user device, such as managed user device 102 include security agent 124. In one embodiment, the network access control policies 244 may specify that the software run by security agent 124 be of a certain version (i.e., the most recently updated version). In another embodiment, the policies 244 may require that the managed user device 102 be capable of certain types of encryption, have a certain level of DLP features, certain types of communications protocols, or certain types of information rights management. The policies may also include the security features of antivirus software, a firewall, intrusion detection systems, threat management systems, or other security features. These policies may be dependent on the type of cloud service being accessed (e.g., private cloud services 132 or public cloud services 134), the type of information being request, or other factors. Network access control module 306 may verify that the requirements of the policy 344 are satisfied for the user device 102 making the request to access the cloud services.

At block 560, method 500 optionally updates the security status of the user device 102, if necessary. For example, network access control policies 244 may specify that the software run by security agent 124 be of a certain version (i.e., the most recently updated version). If the user device 102 was currently running an out-of-date version of the security software, network access control module 306 may instruct it to upgrade to the latest version. In one embodiment, network access control module 306 may provide a software upgrade directly to the user device 102. In another embodiment, however, network access control module 306 may redirect user device 102 to a security provider which may install the update. In either case, the update is performed dynamically and in real time in response to the request. If an access request is received from a device without the security features defined in the policy 344, before responding to the request, network access control module 306 may update the security features on the device 102 to conform to the policy 344. Once the policy 344 is satisfied, access to the requested cloud service may be granted. This may prevent a user from being denied access to a cloud service or cloud based information that he would otherwise be allowed to access, merely because he has not been able to previously update the security features of his user device 102.

At block 570, once it is verified that the device 102 complies with the network access control policies 344, and any

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necessary updates are made at block 560, network access control module 306 may provide access to the request cloud service.

FIG. 6 is a diagram illustrating a workflow for network access control for cloud services, according to an embodiment of the present invention. Workflow 600 may be performed by a combination of systems, including a cloud service access and information gateway, such as gateway 300. The order of the actions described below is merely one possible embodiment, and it should be understood that in other embodiments, the order may change.

In one embodiment, an administrator or user associated with an enterprise 610 (e.g., a certain corporation) may define a network access control policy (601). The administrator may define a network access control that sets a certain level of security required for different, users, devices, information requests, and/or cloud services. In one embodiment, the administrator may load the policy into policy manager 122, which may store the policy as one of network access control policies 244.

Policy manager 122 may distribute the network access control policies 244 to various enforcement points, such as for example gateway 112 (602). The policies 244 may be sent to gateway 112 periodically, according to a predefined schedule, each time a change or update is made to one of the policies, or in response to a request from a user or system administrator.

Gateway 112 may receive a request to access a certain cloud service (603). In one embodiment, the request may be sent by a user device, such as managed user device 102. The request may be for access to a cloud service, such as private cloud service 132. In one embodiment, cloud service access and information gateway 112 may intercept or otherwise receive the access request.

In response to the access request, gateway 112 may request a security status of the user device 102 from which the access request was received (604). In one embodiment, a network access control module 306 of gateway 112 may request information about the security features on user device 102, such as for example whether the user device 102 has certain security software, whether a security agent 124 is running on the user device 102, whether the device is capable of certain types of data encryption, etc. In one embodiment, network access control module 306 may also request the version of the security software or security agent or request a date at which the security was installed. Gateway 112 may receive a response from user device 102 to the request for security status (605).

Gateway 112 may verify the security status of the user device 102 based on the received information (606). In one embodiment, the network access control module 306 in gateway 112 compares the security information received from user device 102 to the network access control policy received from policy manager 122. Network access control module 306 may verify that the requirements of the policy are satisfied for the user device 102 making the request to access the cloud services.

If the security on user device 102 does not meet the requirements of the network access control policy, gateway 112 may redirect the request to security provider 620 (607). If the deficiency is able to be cured, security provider 620 optionally updates the security status of the user device 102. For example, if the user device 102 was currently running an out-of-date version of the security software, security provider 620 may provide a software upgrade directly to the user device 102.

Upon updating the security of user device 102, gateway 112 may generate an audit report reflecting the upgrade (608).

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The audit report may be used by a user or system administrator to verify the security status of user device **102** at a later time. In one embodiment, the audit report is stored in a data store attached to gateway **112**, however, in other embodiments the audit report is stored elsewhere (e.g., transmitted back to policy manager **122** and/or enterprise **610**).

Upon determining that user device **102** complies with the network access control policy, and/or any necessary updates are made to the device security, gateway **112** may provide access to the request cloud service **132** (**609**). Gateway **112** may forward the received access request to private cloud service **132** and exchange any necessary information.

FIG. **7** illustrates a diagrammatic representation of a machine in the exemplary form of a computer system **700** within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. The system **700** may be in the form of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. In alternative embodiments, the machine may be connected (e.g., networked) to other machines in a LAN, an intranet, an extranet, or the Internet. The machine may operate in the capacity of a server machine in client-server network environment. The machine may be a personal computer (PC), a set-top box (STB), a server, a network router, switch or bridge, or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term “machine” shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein. In one embodiment, computer system **700** may represent intelligence center **120** in FIG. **1** and or gateway **300** in FIG. **3**.

The exemplary computer system **700** includes a processing system (processor) **702**, a main memory **704** (e.g., read-only memory (ROM), flash memory, dynamic random access memory (DRAM) such as synchronous DRAM (SDRAM)), a static memory **706** (e.g., flash memory, static random access memory (SRAM)), and a data storage device **718**, which communicate with each other via a bus **730**.

Processor **702** represents one or more general-purpose processing devices such as a microprocessor, central processing unit, or the like. More particularly, the processor **702** may be a complex instruction set computing (CISC) microprocessor, reduced instruction set computing (RISC) microprocessor, very long instruction word (VLIW) microprocessor, or a processor implementing other instruction sets or processors implementing a combination of instruction sets. The processor **702** may also be one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), network processor, or the like. The processor **702** may be configured to execute the cloud service access and information gateway **300** for performing the operations and steps discussed herein.

The computer system **700** may further include a network interface device **708**. The computer system **700** also may include a video display unit **710** (e.g., a liquid crystal display (LCD) or a cathode ray tube (CRT)), an alphanumeric input device **712** (e.g., a keyboard), a cursor control device **714** (e.g., a mouse), and a signal generation device **716** (e.g., a speaker).

The data storage device **718** may include a computer-readable medium **728** on which is stored one or more sets of instructions **722** (e.g., instructions of gateway **300**) embody-

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ing any one or more of the methodologies or functions described herein. The instructions **722** may also reside, completely or at least partially, within the main memory **704** and/or within processing logic **726** of the processor **702** during execution thereof by the computer system **700**, the main memory **704** and the processor **702** also constituting computer-readable media. The instructions may further be transmitted or received over a network **720** via the network interface device **708**.

While the computer-readable storage medium **728** is shown in an exemplary embodiment to be a single medium, the term “computer-readable storage medium” should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that store the one or more sets of instructions. The term “computer-readable storage medium” shall also be taken to include any medium that is capable of storing, encoding or carrying a set of instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies of the present invention. The term “computer-readable storage medium” shall accordingly be taken to include, but not be limited to, solid-state memories, optical media, and magnetic media.

In the above description, numerous details are set forth. It will be apparent, however, to one of ordinary skill in the art having the benefit of this disclosure, that embodiments of the invention may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring the description.

Some portions of the detailed description are presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorithmic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the above discussion, it is appreciated that throughout the description, discussions utilizing terms such as “determining”, “identifying”, “adding”, “selecting” or the like, refer to the actions and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (e.g., electronic) quantities within the computer system’s registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

Embodiments of the invention also relate to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, or it may comprise a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer read-

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able storage medium, such as, but not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions.

The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct a more specialized apparatus to perform the required method steps. The required structure for a variety of these systems will appear from the description below. In addition, the present invention is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein.

It is to be understood that the above description is intended to be illustrative, and not restrictive. Many other embodiments will be apparent to those of skill in the art upon reading and understanding the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

What is claimed is:

1. A method, comprising:

receiving, from a user device, a request to access a cloud service;

comparing, by a processor, a security status of the user device to a network access control policy for the cloud service, wherein the network access control policy defines a level of security specifying a set of security features for the user device based on a category of the user device, a category of information requested, and a category of the cloud service and specifies at least one condition, the condition comprising a presence of an updated version of a security agent on the user device;

determining that the user device does not include the updated version of the security agent as specified by the condition of the network access control policy;

determining an update to the security status of the user device that will cause the security status of the user device to satisfy the condition for future requests to access the cloud service;

redirecting the request to a security provider, the security provider to provide an updated version of the security agent to the user device in order to satisfy the condition of the network access control policy; and

upon determining that the security status of the user device satisfies the condition of the network access control policy granting the user device access to the cloud service.

2. The method of claim 1, wherein the cloud service comprises at least one of a public cloud service or a private cloud service.

3. The method of claim 1, wherein the network access control policy comprises one of a plurality of network access control policies.

4. The method of claim 3, wherein the condition comprises at least one of a presence of security software, a security signature or an encryption capability.

5. The method of claim 1, wherein a cloud service access and information gateway compares the security status of the user device to the network access control policy.

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6. The method of claim 5, wherein the cloud service access and information gateway is independent of the user device and the cloud service.

7. The method of claim 1, wherein determining the update to the security status of the device comprises identifying at least one of security software, a security agent, a security signature or an encryption capability in real time before responding to the request.

8. A system, comprising:

a memory; and

a processor coupled with the memory to:

receive, from a user device, a request to access a cloud service;

compare a security status of the user device to a network access control policy for the cloud service, wherein the network access control policy defines a level of security specifying a set of security features for the user device based on a category of the user device, a category of information requested, and a category of the cloud service and specifies at least one condition, the condition comprising a presence of an updated version of a security agent on the user device;

determine that the user device does not include the updated version of the security agent as specified by the condition of the network access control policy;

determine an update to the security status of the user device that will cause the security status of the user device to satisfy the condition for future requests to access the cloud service;

redirect the request to a security provider, the security provider to provide an updated version of the security agent to the user device in order to satisfy the condition of the network access control policy; and

upon determining that the security status of the user device satisfies the condition of the network access control policy, grant the user device access to the cloud service.

9. The system of claim 8, wherein the cloud service comprises at least one of a public cloud service or a private cloud service.

10. The system of claim 8, wherein the network access control policy comprises one of a plurality of network access control policies.

11. The system of claim 10, wherein the condition comprises at least one of a presence of security software, a security signature or an encryption capability.

12. The system of claim 8, wherein a cloud service access and information gateway compares the security status of the user device to the network access control policy.

13. The system of claim 12, wherein the cloud service access and information gateway is independent of the user device and the cloud service.

14. The system of claim 8, wherein to determine the update to the security status of the device, the processor to identify at least one of security software, a security agent, a security signature or an encryption capability in real time before responding to the request.

15. A non-transitory computer readable storage medium including instructions that, when executed by a processor, cause the processor to perform operations comprising:

receiving, from a user device, a request to access a cloud service;

comparing, by a processor, a security status of the user device to a network access control policy for the cloud service, wherein the network access control policy defines a level of security specifying a set of security features for the user device based on a category of the

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user device, a category of information requested, and a category of the cloud service and specifies at least one condition, the condition comprising a presence of an updated version of a security agent on the user device; determining that the user device does not include the updated version of the security agent as specified by the condition of the network access control policy; determining an update to the security status of the user device that will cause the security status of the user device to satisfy the condition for future requests to access the cloud service; redirecting the request to a security provider, the security provider to provide an updated version of the security agent to the user device in order to satisfy the condition of the network access control policy; and upon determining that the security status of the user device satisfies the condition of the network access control policy, granting the user device access to the cloud service.

16. The non-transitory computer readable storage medium of claim **15**, wherein the cloud service comprises at least one of a public cloud service or a private cloud service.

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17. The non-transitory computer readable storage medium of claim **15**, wherein the condition comprises at least one of a presence of security software, a security signature or an encryption capability.

18. The non-transitory computer readable storage medium of claim **15**, wherein a cloud service access and information gateway compares the security status of the user device to the network access control policy.

19. The non-transitory computer readable storage medium of claim **18**, wherein the cloud service access and information gateway is independent of the user device and the cloud service.

20. The non-transitory computer readable storage medium of claim **15**, wherein determining the update to the security status of the device comprises identifying at least one of security software, a security agent, a security signature or an encryption capability in real time before responding to the request.

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